

FORMULA GR-2

MACHINE SPECIFICATIONS

CAPACITY:

10-3/4" dia. 3 jaw grinding chuck -	
Maximum outside diameter of work	= 5-1/2"
13-3/4" dia. 3 jaw grinding chuck -	
Maximum outside diameter of work	= 8-1/2"
Fixture or face plate on spindle nose -	= 16"
Maximum outside diameter	

WORK SPEEDS:

160 RPM
240 RPM
325 RPM
480 RPM

TABLE TRAVERSE RATE:

0-35 feet per minute (Hydraulic)

WORKHEAD SWIVEL:

Maximum with guard	- 15°
Maximum without guard	- 35°

AD 600 197

Contents

INDEX

SECTION

I FORMULA REPORT, WORK SHEETS AND INSTRUCTIONS

II CHARTS

III LIST OF CONSTANTS AND SYNTHESIS

VI TABLE OF ELEMENTS AND METHODS ANALYSIS SHEETS

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FORMULA GR-2

SECTION I

FORMULA REPORT, WORK SHEETS AND INSTRUCTIONS

FORMULA CR-2

HEALD 72-A INTERNAL GRINDER

FORMULA REPORT

PARTS: All parts which are within capacity of the machine.

OPERATIONS: All Internal Grinding, including Traverse, Plunge, Taper, Radius and Face Grinding.

MATERIALS: All materials commonly ground on an Internal Grinder.

WORK STATION: Department 637-1, Heald 72-A Internal Grinder.

ALLOWED TIME: Set-up - Time in decimal hours as computed from set-up work sheet.

Each Piece - Time in decimal hours as computed from each piece work sheet.

ALLOWANCES: All times shown on work sheets and in charts are expressed in levelled decimal hours without allowances. A standard allowance of 15% must be added to all total times to compensate the average operator for fatigue, personal and unavoidable delays, and required wheel changes.

APPLICATION: This Formula applies to all operations commonly performed on the Heald 72-A Internal Grinder.

ANALYSIS: Time values contained in this Formula apply to operations as performed on the Heald 72-A Internal Grinder during October 1956. If there are any future changes in methods, conditions, material, or equipment the time values must be revised to compensate for such changes.

Basic element times were determined by direct observation and application of MTM data. Constant time values shown on work sheets were developed by synthesizing basic elements.

Tools and grinding equipment such as 0"-1" Micrometer, 6" Scale, Allen Wrenches, Open end Wrenches, Diamond Dressers, Dressing "Sticks", and Hammers are assumed to be readily available to the operator, either from his own tool box or from a co-worker's.

Machine equipment such as Chucks, Chuck Jaws, Wheelheads, Face Plates, Grinding Wheels and Blotters, Chuck Spiders, Finger back Stops, Radius Dresser, Quills, and Nuts and Bolts are assumed to be available at the department tool cabinets or wheelhead storage rack.

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Measuring devices and tools such as Height Gages, Verniers, Indicators, Large Micrometers, "V" Blocks, and parallel Bars, which are not specified on the operation sheet must be obtained from the Tool Crib. Special tools and gages listed on the operation sheet are delivered to the operator by the transfer man. The transfer man also brings parts to the machine and removes completed parts. It is assumed that the operator is capable of setting up the machine and making all adjustments necessary to produce dimensionally correct parts. The first correct piece produced by the operator must be checked by the Supervisor and approved before additional pieces are run. The first piece must be submitted to inspection for approval after it is approved by the Supervisor.

PROCEDURE: Set-up - Operator is assigned a job by his Supervisor, clocks in on set-up and returns to the Supervisor for blueprint and instructions. The operator then studies his operation sheet and blueprint, gets the required tools and equipment and proceeds to set-up his machine. All necessary trial cuts, alignments and setting adjustments are part of the set-up. The operator submits his first correct part to his Supervisor for approval, then turns the part over to Inspection, clocks off set-up and on piece part time, and returns to machine.

Each Piece - Operator gets a part from floor or bench, places it in holding device and performs the necessary grinding operations. All required gauging and machine adjustment necessary to maintain dimensionally correct parts are performed by the operator.

FORMULA CR-2

HEALD 72-A INTERNAL GRINDER

WORK SHEET - SET-UP

Oper. #

SP/SC#

Inst. No.	"R" No.	Description	Hours	Occ.	Total Hours
1-A	1	Set-Up. Initial And Machine <u>Set up Holding Device:</u>	1.1202	1	1.1202
2-A	27	3 Jaw Chuck	.7186		
B	37	Additional For Finger Back Stops	.2841		
C	35	Fixture	.2133		
D	45	Fixture on Magnetic Chuck	.0256		
E	34	Face Plate	.1965		
F	2	Additional for Workhead Guard	.0273		
G	53	Extended Bridge	.2965		
3-A	38	Set-up: Radius Dresser	.3230		
4-A	21	Align: Wheelhead with Shim	.0531		
		<u>Set-up Stops:</u>			
5-A	11	Each Table Traverse or Stop Dog	.0044		
B	12	One Table Barrel Stop	.0074		
C	13	One Workhead Barrel Stop	.0157		
D	14	Each Additional Barrel Stop	.0202		
6-A	49	Supervisor's First Piece Approval	.1152	1	.1152
7-A		Trial Grind Time Allowed: Each Piece Time _____ x 3 = _____ Gage Each Size _____ x .0300 = _____			
		TOTAL			

TOTAL TIME _____

ALLOWANCE % _____

ALLOWED TIME _____

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HEALD 72A INTERNAL GRINDER

Issue 57 Rev 29/524
By Super Date / /
Oper. #

Total Time _____
Allowance _____ %
Allowed Time _____

FORMULA GR-2

WORK SHEET INSTRUCTIONS
SET-UP

- 1-A Initial and machine set-up is allowed once per job order.
- 2-A Set-up 3 Jaw Chuck is allowed once per job order when a 3 Jaw Grinder Chuck is used as a holding device.
- 2-B Additional for finger back stops in chuck is allowed once per job order where finger back stops are used in a 3 Jaw Grinding Chuck. These Back Stops permit each piece part to maintain a constant location in the chuck. This time is allowed in addition to 2-A..
- 2-C Set-up fixture is allowed once per job order when a fixture is used as a holding device. This time is allowed only when the fixture must be mounted on the machine spindle nose or on a face plate.
- 2-D Set-up fixture on magnetic chuck is allowed once per job order when a fixture is used as a holding device. This time is allowed only when the fixture is mounted on a magnetic chuck.
- 2-E Set-up face plate is allowed once per job order when a face plate is used as a holding device. This time is allowed when either a fixture or a piece part is to be mounted on a face plate.
- 2-F Additional for workhead guard is allowed once when the workhead guard must be removed to permit the workhead to swivel over 15°. Under 15° the workhead can be swiveled without removing the guard.
- 2-G Additional set-up for extended bridge is allowed once per set-up when an extended bridge grinder is used. This time includes setting up a steadyrest and positioning of the workhead on the extended bridge.
- 3-A Set-up Radius Dresser is allowed once per job order when a radius dresser is used.
- 4-A Align wheelhead with shim is allowed once per job order for aligning the wheelhead with shim stock. This time is allowed only when face grinding to a squareness of 6' or less, and/or when face grinding to a dimension of a total tolerance of .002" or less.
- 5-A Set-up each table traverse or stop dog is allowed once per job order for each table traverse or stop dog. Traverse dogs are used only for traverse grinding. The stop dog is used for plunge grinding, face grinding and as a safety stop for traverse grinding.
- 5-B Set-up one table barrel stop is allowed once per job order when only one table stop is required.

FORMULA GR-2

5-C Set-up one workhead barrel stop is allowed once per job order when only one workhead stop is required.

5-D Set-up each additional barrel stop is allowed once per job order for each additional stop on the workhead or table barrel stop. This time is allowed in addition to 5-B and/or 5-C.

6-A Supervisor's first piece approval is allowed once per job order.

7-A Trial grind time is allowed once per job order. Each first piece time is obtained by multiplying the total time from each piece work sheet by 3 / checking time. Checking time is obtained by multiplying the number of dimensions to be held in the operation by .0300 hour.

EXAMPLE: Time per piece = .025 hr. - 2 dimensions to be held.
(Time per piece x 3) / (no. of dimensions x .0300 hr.) =
(.0250 hr. x 3) / (2 x .0300 hr.) = .0750 hr / .0600 hr. =
.1250 hr. = Trial Grind Time.

EACH PIECE

8-A Constant per piece is allowed once for each piece. One occurrence is allowed for each additional dimension to be ground.
For Example: An operation which calls for grinding two diameters and one face would require two additional occurrences. Additional occurrences are also allowed where close tolerances require a series of sizing cuts. In this case one occurrence is allowed for each sizing cut.

Rules for determining the number of sizing cuts required:
(1) Diameter tolerance of ".0003 or less allow 3 sizing cuts.
(2) Diameter tolerance of ".0004 to ".001 allow 2 sizing cut.
(3) Step dimension tolerance of -".003 or less allow 2 sizing cut.

9-A Handle part 5# or less is allowed once for each piece weighing 5# or less.

9-B Handle part over 5# is allowed once for each piece weighing over 5#.

10-A 3 Jaw Chuck is allowed once for each piece using a 3 Jaw chuck as a holding device.

10-B Magnetic chuck is allowed once for each piece using a magnetic chuck as a holding device.

10-C Fixture is allowed once for each piece using a fixture as a holding device. This time is obtained from Formula F-3.

10-D Steadyrest is allowed once for each piece when a steadyrest on the extended bridge grinder is used to support a long part. This time is allowed in addition to 10-A or 10-C.

FORMULA GR-2

11-A True-up part with indicator and hammer is allowed once for each piece where a piece part held in a fixture must be trued-up with an indicator and a hammer.

11-B True-up part with indicator and adjusting screws is allowed once for each piece where a piece part, held in a fixture, must be trued with an indicator and adjusting screws.

12-A Index each table barrel stop is allowed once for each additional table stop required.

13-A Dress wheel diameter with diamond is allowed once for each piece. Allow twice when a length of hole to be ground is 3" or more.

13-B Dress wheel face or radius by hand is allowed once for each time the face of grinding wheel is dressed by hand to face grind or to grind a fillet inside a blind hole. Allow once per piece for each face; 1/2 for each fillet.

13-C Dress wheel with radius dresser is allowed once for each time a radius or a grinding wheel is dressed with a radius dresser.

14-A Deburr one sharp edge is allowed once for the first or single sharp edge.

14-B Deburr each additional sharp edge is allowed once for each additional sharp edge.

15-A Gauge time values are obtained from gauging Formula GAU-1. Allow sufficient gauging to insure the accuracy of the operation sheet tolerances and naval ordnance specifications.

Rules to determine the approximate number of gageings required:

- (1) When the tolerance of a diameter exceeds .003 the allowed inspection time (Chart 1-C from NOPP Gauging Formula GAU-1) shall be used. For a tolerance of ".002 and under the following rules will apply.
- (2) For a tolerance of ".0011 to ".002 allow 1 gaging
- (3) For a tolerance of ".0007 to ".001 allow 2 gageings
- (4) For a tolerance of ".0004 to ".0006 allow 3 gageings
- (5) For a tolerance of ".0003 or less allow 4 gageings
- (6) When a tolerance of a step dimension exceeds ".005 allow 1 gaging
- (7) For a step dimension of ".003 to .005 allow 2 gageings
- (8) For a step dimension of less than ".003 allow 3 gageings

FORMULA CR-2

16-A Machine Time - Traverse grind values are computed from Chart #2. Chart #2 shows the recommended amount of stock to be removed per stroke for a given material and the time in decimal hours for one inch of stroke. To obtain the number of strokes required, divide the total stock to be removed by the amount of stock to be removed per stroke.

EXAMPLE: Grind a hardened steel bore diameter 3.000" long from 1.380" diameter to 1.406" diameter and hold a 32 micro finish.

The amount of stock to be removed = .026"

From Chart #2: Stock to be removed per stroke = .0002"

From Chart #2: Time per one inch per stroke = .0003 hr.

From Chart #2: 8 additional strokes for 32 micro finish. The number of strokes = (.026 divided by .0002) / 8 = 130 + 8 = 138

Traverse Grind Time = Number of strokes (138) x Time for inch stroke (.0003 hr.) x length of Bore (3".000) = 138 x .0003 hr x 3".000 = .1242

16-B Plunge grind values are computed from Chart #3. Chart #3 shows the time in decimal hours to rough grind .001" stock of a given material and the time to finish grind.

EXAMPLE: Plunge grind a carbon steel part, whose bore diameter is 1.435, to a finish size of 1.448 diameter.

From Chart #3, using 1 1/2" bore dia. as the next higher dia. and under the carbon steel column, the time to remove .001" stock = .0013 hour.

The amount of stock to be removed is .013 (1.448 - 1.435 = .013")

The time to remove .013" = (13 x .0013 hour) + (4 x .0013 hour) (see note Chart #3) = .0169 hour + .0052 hour = .0221 hour

16-C Face grind values are obtained from Chart #4.

EXAMPLE: Face grind an alloy steel part with a workhead speed of 160 RPM and .008" stock to be removed. A required 32 RMS (finish) must be obtained.

From Chart #4 obtain the time to remove .008" stock = .0046 / 10 revolutions of workhead for a 32 RMS (finish) with a time value of .0001 hr. per rev. = .0046 hr. / (10 x .0001 hr.) = .0046 hr. / .0010 hr. = .0056 hr. = total time.

FORMULA GR-2

SECTION II

CHARTS

HOFF GAGING FORMULA GAU-1
Chart 1

Use	Instr. No.	Instrument No.	Description	Allowed Time
6"				
Scale	1	K-2	Scale dimension to 1/16"	.0025
12"				
Scale	1	K-3	Scale dimension to 1/16"	.0030
36"				
Scale	1	K-4	Scale dimension to 1/16"	.0030
	2	K-30	Additional for reading scale to .010	.0030
Outside		K-5	Measure dimension up to 3". Read to .001	.0036
Micrometer	3	K-6	Measure dim. over 3" up to 12". Read to .0075	
		.001		
		K-7	Measure dim. over 12". Read to .001	.0092
			Add. for reading mic. closer than .001	.0018
Inside		K-11	Measure dim. 0" to 4". Read to .001	.0118
Micrometer	4	K-12	Measure dim. over 4" up to 12". Read to .001	.0124
		K-13	Measure dim. over 12". Read to .001	.0151
			Add. for reading mic. closer than .001	.0018
Depth		K-15	Measure dimension up to 3"	.0062
	5	K-16	Measure dimension over 3"	.0067
Micrometer		K-17	Additional for a difficult position	.0023
Vernier		K-36	Measure dimension under 12"	.0132
Calipers	6	K-37	Measure dimension over 12"	.0156
Depth				
Vernier	7	K-38	Measure dimension 0" to 12"	.0140
Vernier		K-40	Measure dimension	.0167
Height Gauge	8	K-44	Measure dim. with Indicator & Gauge Blocks	.0159
Telescope or			Measure dim. with telescope or small	
Ball Gauge	9	K-9	hole gage.	.0079
Plug		K-26	Use plug gauge under 2".	.0044
Gauge	10	K-27	Use plug gauge over 2".	.0057
Thread			Ring thd. gauge) see charts 1-a & 1-b	.0022
Gauges	11	K-18	Ring thd. gauge)	
Outside		K-30	Use spring caliper up to 8"	.0104
Calipers	12	K-33	Use firm joint calipers 8" to 24"	.0140
Inside		K-31	Use spring calipers up to 8"	.0109
Calipers	13	K-34	Use firm joint calipers 8" to 24"	.0180
Surface			Use surface gauge with indicator and	
Gauge	14	K-44	gauge blocks.	.0159
Feeler				
Gauge	15	K-47	Use feeler gauge each point.	.0030
Radius Angle	16	K-11	Use, Radius, Angle, or Profile Gauge.	.0045
Profile		K-19		
Adjustable				
Parallels	17	K-21	Use adjustable parallels.	.0083
Electro				
Limit Gauge	18	K-48	Use electro limit gauge	.0092
Dial Bore	19	K-49	Use dial bore or Precisionaire gauge	.0065
Precisionaire				
Square or	20	K-13	Use square or protractor.	.0044
Protractor				
Comparitor	21	K-51	Measure one dimension	.0470
	22	K-52	Each Additional Dimension	.0325

FORMULA GR-2

CHART #2 - TRAVERSE GRIND
 Recommended RPM Stock Removal Per Stroke
 and Grinding Time Per Inch of Stroke

Bore Dia.	SPM	Avail RPM	Stock to be removed per stroke in inches			
			Hardened Steel, Corr. Res. Steel 30 SPM	Carbon and Alloy Steel 50 SPM	Brass, Bronze & Copper 75 SPM	Inch Stroke Time in Hours
1/4"	30-50-75	480	.0001	.0002	.0002	.00015
	30	325	.0001			.00020
5/8"	50-75	480		.0002	.0002	.00015
	30	240	.0001			.00025
1/2"	50	325		.0002		.00020
	75	480			.0002	.00015
3/8"	30	160	.0001			.00030
	50	325		.0002		.00020
7/8"	75	480			.0002	.00015
	30	160	.0002			.00030
to	50	240		.0002		.00025
	75	325			.0002	.00020
1"	30-50	160	.0002	.0002		.00030
	75	240			.0002	.00025
1-1/4"	30-50	160	.0002	.0002		.00030
	75	240			.0002	.00025
1-1/2"	30-50-75	160	.0002	.0002	.0002	.00030
	over					

It is recommended that additional strokes be allowed for the following:

A total dia. tolerance of .001 or less allow 8 strokes

A 63 RMS allow 4 strokes

A 32 RMS allow 8 strokes

A 16 RMS or better allow 12 strokes

NOTE: For a bore 3/8" dia. and under where the length is at least 2 times the dia., use 25% of the recommended stock removal per stroke, and 4 times the number of additional strokes.

For a bore 3/8" to 5/8" dia. where the length is at least 2 1/2 times the dia., use 33% of the recommended stock removal per stroke, and 3 times the number of additional strokes.

For a bore of over 5/8" dia. where the length is at least 4 times the dia., use 75% of the recommended stock removal per stroke, and 2 times the number of additional strokes.

Grind Time = $L \times N \times T$
 Where L = Length of Stroke
 Where N = Number of Strokes = $\frac{\text{Stock to be removed}}{\text{Stock removal per stroke}}$
 Where T = Time in hours per one inch of stroke

FORMULA GR-2

CHART #3 - Plunge Grind

Grinding Time For .001" Stock Removal

Hardened Steel and Corr. Res. Steel;	Remove ".00007 Per Rev.
Alloy Steel;	Remove ".00010 Per Rev.
Carbon Steel;	Remove ".00010 Per Rev.
Brass, Bronze and Copper;	Remove ".00007 Per Rev.

Bore Dia.	SPM	Avail RPM	Time in Dec. Mrs. to Remove ".001 Stock		
			Hardened Steel Corr. Res. Steel 30 SPM	Alloy & Carbon Steel 50 SPM	Brass, Bronze and Copper 75 SPM
3/8 & under	30	325	.0008		
	50-75	480		.0004	.0006
1/2 "	30	240	.0010		
	50	325		.0005	
5/8 "	75	480			.0006
	30	160	.0014		
3/4 "	50	325		.0005	
	75	480			.0006
7/8 "	30	160	.0014		
	50	240		.0007	
1 "	75	325			.0007
	30-50	160	.0014	.0010	
1 1/4 "	75	240			.0010
	30-50-75	160	.0018	.0013	.0015
1 3/4 "	30-50-75	160	.0021	.0015	.0016
	2 "	30-50-75	160	.0024	.0018
2 1/4 "	30-50-75	160	.0027	.0020	.0018
	2 1/2 "	30-50-75	160	.0030	.0022
2 3/4 "	30-50-75	160	.0033	.0014	.0024
	3 "	30-50-75	160	.0036	.0026
Over 3"	30-50-75	160	.0040	.0030	.0030

NOTE: Allow the time for an additional .004" to cover the time required for Sparkout.

CHART #4

Hardened Steel, Corr. Res. Steel _____
 All other Steel, & non-ferrous metals _____

It is recommended that time for 20 revolutions
 required 30 revolutions where a 16 RMS or

Material	Avg.	Time	Per Rev.	001	.00	.001	.00	Stock
Material	RPM							
Hardened	160	.00010	.020	.0016	.00	.0036	.004	
Steel	240	.00009	.014	.0014	.00	.0028	.003	
Corr. Res.	325	.00008	.011	.0016	.00	.0021	.002	
Steel	480	.00007	.009	.0014	.00	.0018	.002	
All other	160	.00012	.011	.0016	.00	.0031	.002	
Steel &	240	.00007	.010	.0014	.00	.0017	.002	
Non ferrous	325	.00005	.009	.0011	.00	.0014	.001	
metals	480	.00004	.008	.0010	.00	.0012	.001	

Derivation of Chart 4.

.016
RP

RPM = Revolutions per minute,

.016

S = Amount of stock to be removed,

.0006 = W3 in Dec. Hours (Constant)

FORMULA GR-2

GRIND TIME

Remove .0001" Per Rev.
Remove .0002" Per Rev.

allowed for Sparkout where a 32 RMS is
s required.

removed in inches					
.006	.007	.008	.009	.010	.011
.0066	.0076	.0086	.0096	.0106	.0116
.0049	.0056	.0063	.0070	.0077	.0084
.0036	.0041	.0046	.0051	.0056	.0061
.0030	.0034	.0048	.0042	.0046	.0050
.0036	.0041	.0046	.0051	.0056	.0061
.0027	.0031	.0034	.0038	.0041	.0044
.0021	.0024	.0026	.0029	.0031	.0034
.0018	.0020	.0022	.0024	.0026	.0028

+ .0006 = Allowed Time

minute in Dec. Hours

eed Per Revolution

FORMULA GR-2

SECTION III

LIST OF CONSTANTS AND SYNTHESIS

FORMULA GR-2

LIST OF CONSTANTS

<u>"K"</u>		<u>MIN</u>	<u>DEC.</u>
			<u>HOURS</u>
K-1	Initial and machine set-up	112015.3	1.1202
K-2	Set-up workhead guard	2727.0	.0273
K-3	Use one screw	626.6	.0063
K-4	Use each washer	100.8	.0010
K-5	Obtain tool from toolbox	647.4	.0065
K-6	Obtain and lay aside tool on bench	164.3	.0016
K-7	Obtain tools in cabinet	6610.8	.0661
K-8	Set-up surface gage and indicator	658.1	.0066
K-9	Use indicator	435.2	.0044
K-10	True-up object with indicator	1674.2	.0167
K-11	Set-up one table traverse or stop dog	436.6	.0044
K-12	Set-up one table barrel stop	743.2	.0074
K-13	Set-up one workhead barrel stop	1574.0	.0157
K-14	Additional set-up for each barrel stop	2022.1	.0202
K-15	Index table barrel stop one position	153.0	.0015
K-16	Index workhead barrel stop one position	387.7	.0039
K-17	Change grinding wheel	2643.7	.0264
K-18	Mount Wheelhead	4130.5	.0413
K-19	Change quill on wheelhead	2320.4	.0232
K-20	Set-up wheelhead	12676.0	.1268
K-21	Align wheelhead with shim	5310.7	.0531
K-22	Constant per piece	660.2	.0066
K-23	Dress wheel face by hand	129.3	.0013
K-24	Mount face plate	9667.2	.0967
K-25	Remove chuck, fixture or face plate	4992.7	.0499
K-26	Mount 3 jaws in chuck	12062.1	.1206
K-27	Set-up 3 jaw chuck	71859.0	.7186
K-28	Grind jaws	37042.4	.3704
K-29	Set-up coolant	1416.0	.0142
K-30	Set-up truing unit	12509.1	.1251
K-31	Align workhead	21382.7	.2138
K-32	Dress diameter of wheel with diamond	803.3	.0080
K-33	Set-up machine	57634.8	.5763
K-34	Set-up face plate	19652.6	.1965
K-35	Set-up fixture	21326.8	.2133
K-36	Assemble 3 chuck finger stops	14769.3	.1477
K-37	Set-up finger back stops in chuck	28412.9	.2841
K-38	Set-up radius dresser	32299.4	.3230
K-39	Dress radius of wheel with radius dresser	740.8	.0074
K-40	Use air chuck	304.9	.0030
K-41	Use spring chuck	365.3	.0037
K-42	Use magnetic chuck	2293.0	.0229
K-43	Handle part 5# and under	350.1	.0035
K-44	Handle part over 5#	500.1	.0050
K-45	Set up fixture on magnetic chuck	2559.4	.0256
K-46	Deburr sharp edge	172.7	.0017
K-47	Deburr each additional sharp edge	83.0	.0008
K-48	True-up part in fixture with adjusting screws	2142.6	.0214
K-49	Supervisor's first piece approval	11521.4	.1152

FORMULA GR-2

K-50	Set-up workhead on extended bridge	16440.7	.1644
K-51	Set-up steadyrest on extended bridge	11387.7	.1139
K-52	Use steadyrest on extended bridge	365.2	.0037
K-53	Additional set-up for extended bridge	29654.3	.2965

FORMULA GR-2

	SYNTHESIS	THU	Dec <u>Hours</u>
K-1	Initial and machine set-up	112015.3	1.1202
A	Walk to supervisors desk or timekeeper & return	12774.4 6387.2x2	
B	Walk to tool crib and return	12637.2	
L	Study blueprint and operation sheet(average)	5000.0	
K-7	Obtain tools in cabinet	6610.8	
K-8	Set-up surface gage & indicator	658.1	
K-33	Set-up machine	57634.8	
	Time to clean machine	16700.0	
K-2	Set-up workhead guard	2727.0	.0273
A-4	Mount workhead guard	267.6	
B-4	Remove workhead guard	181.2	
K-6	Obtain and lay aside tool on bench	164.3x2	328.6
H	Walk to rear of machine and return	397.2x2	794.4
D-2	Tighten or loosen each screw with wrench	88.2x6	529.2
K-3	Use one screw	626.0	.0063
A-2	Move each screw to hole and engage	110.7	
B-2	Run down each screw by hand	162.1	
C-2	Run out each screw by hand and lay aside	176.8	
D-2	Tighten or loosen each screw with wrench	88.2x2	176.4
K-4	Use each washer	100.8	.0010
E-2	Place each washer on stud	56.2	
F-2	Remove and lay aside each washer	44.6	
K-5	Obtain tools from tool box	647.4	.0065
N	Open and close toolbox drawer	57.4x3	172.2
P	Get tool from toolbox and return	63.0x6	378.0
Q	To workbench and back	97.2	
K-6	Obtain and lay aside tool on bench	164.3	.0016
Q	To workbench and back	97.2	
G-4	Pick up and lay aside tool	67.1	
K-7	Obtain tools in cabinet	6610.8	.0661
C	Walk to cabinet & return	2337.2x2	4674.4
F	Obtain and replace tool in cabinet	99.0x6	594.0
M	Open & close cabinet doors	85.7x4	342.8
G-4	Pickup and lay aside tool	67.1x12	805.2
Q	To workbench and back	97.2x2	194.4
K-8	Set up surface gage and indicator	658.1	.0066
V	Assemble indicator to surface gage	432.5	
W	Disassemble indicator from surface gage	225.6	

FORMULA GR-2

	SYNTHESIS (Contd)	TMU	Dec Hours
K-9	Use indicator	435.2	.0044
Y	Read indicator	90.1	
S-3	Wipe small object off with cloth	110.0	
S-4	Move indicator to part	70.8	
K-6	Obtain and lay aside tool on bench	164.3	
K-10	True-up object with indicator	1674.2	.0167
K-9	Use indicator	435.2	
G-3	Tap object with hammer	102.3x3	306.9
Y	Read indicator	90.1x2	180.2
G-4	Pick up and lay aside tool		67.1
T	Turn workhead spindle by hand	58.1x10	581.0
S	Turn workhead spindle with "jog" button	34.6x3	103.8
K-11	Set-up one table traverse or stop dog	436.6	.0044
J-2	Move one table traverse or stop dog	215.2	
L-2	Adjust one table traverse or stop dog	73.8x3	221.4
K-12	Set-up one table barrel stop	743.2	.0074
K-11	Set-up one table stop dog	436.6	
F-3	Move table by hand	153.3x2	306.6
K-13	Set-up one workhead barrel stop	1574.0	.0157
D-2	Tighten or loosen each nut with wrench	88.2x4	352.8
J-4	Move workhead barrel stop unit to or from		
	indicator	38.3x2	76.6
G-4	Pick-up and lay aside tool	67.1x3	201.3
H-2	Index barrel stop one position		153.0
K-6	Obtain and lay aside tool on bench		164.3
K-3	Use one screw		626.0
K-14	Additional set-up for each barrel stop	2022.1	.0202
F-3	Move table by hand	153.3x2	306.6
H-2	Index barrel stop one position		153.0
G-4	Pick-up and lay aside tool		67.1
K-5	Obtain tools from toolbox		647.4
K-3	Use one screw		626.6
L-2	Adjust one table stop dog (Sim.Mot.Pat.)	73.8x3	221.4
K-15	Index table barrel stop one position	153.0	.0015
H-2	Index barrel stop one position		153.0
K-16	Index workhead barrel stop one position	387.7	.0039
H-2	Index barrel stop position		153.0
M-3	Move workhead cross slide		148.2
N-3	Move workhead cross slide to dial reading		86.5

FORMULA CR-2

	SYNTHESIS (Cont'd).	THU	Dec. Hours
K-17	Change grinding wheel	2643.7	.0264
Y-2	Mount & remove grinding wheel	239.4	
T-3	Dress diameter of wheel with carborundum "stick"	451.4	
K-3	Use one screw	626.6	
K-6	Obtain & lay aside tool on bench	164.3	
G-4	Pickup and lay aside tool 67.1x2	134.2	
U-3	Set stop on wheelhead cross slide hardwheel	224.5	
K-32	Dress diameter of wheel with diamond	803.3	
K-18	Mount wheelhead	4130.5	.0413
U-2	Mount and remove wheelhead	413.6	
Z-2	Mount and remove wheelhead drive belt	208.4	
A-3	Tighten and loosen wheelhead drive belt	140.8	
D-3	Raise and lower grinding wheel guard by hand	318.0	
S-3	Wipe large object off with cloth 163.4x2	326.8	
Q-3	Tap object with hammer 102.3x2	204.6	
G-4	Pick up and lay aside tool 67.1x3	201.3	
D-2	Tighten or loosen each screw or nut with wrench 88.2x6	529.2	
U	Adjust length of wheel guard	41.7	
K-6	Obtain and lay aside tool on bench 164.3x3	492.9	
K-3	Use one screw 626.6x2	1253.2	
K-19	Change quill on wheelhead	2320.4	.0232
X-2	Block wheelhead spindle 212.3x2	424.6	
K-3	Mount & remove quill (Sim.Mot.Pat.)	626.6	
K-6	Obtain and lay aside tool on bench 164.3x2	328.6	
G-4	Pick up and lay aside tool 67.1x6	402.6	
D-3	Raise and lower wheelhead drive guard(S.M.P)	318.0	
S-3	Wipe small object with cloth 110.0x2	220.0	
K-20	Set-up wheelhead	12676.0	.1268
D	Walk to wheelhead storage rack & return	3237.2	
E	Obtain and replace wheelhead at storage rack	344.2	
K-17	Change grinding wheel	2643.7	
K-18	Mount wheelhead	4130.5	
K-19	Change quill on wheelhead	2320.4	
K-21	Align wheelhead with shim	5310.7	.0531
V-2	Place shim under wheelhead 118.1x2	236.2	
W-2	Remove shim from under wheelhead 89.8x2	179.6	
D-2	Tighten or loosen each screw with wrench 88.2x8	705.6	
K-22	Operate machine each dimension 660.2x3	1980.6	
W-3	Bring grinding wheel to face of work with facing attachment 62.7x3	188.1	
	Use 6" scale - Formula GA-1 (K-2) 250.0x3	750.0	
	Clean-up grind the face est. 150.0x3	450.0	
K-23	Dress wheel face by hand 129.3x3	387.9	
G-4	Pick up and lay aside tool 67.1x4	268.4	
K-6	Obtain and lay aside tool on bench	164.3	

FORMULA GR-2

			<u>Dec.</u>	<u>TMU</u>	<u>Hours</u>
		SYNTHESES			
		(Cont'd)			
K-22	Constant per piece			660.2	.0066
W-1	Set table traverse speed	54.6x2		109.2	
E-3	Reverse table traverse by hand	35.2x2		70.4	
L-3	Move wheelhead cross slide	90.3x2		180.6	
	Hydraulic table traverse time (est)			300.0	
K-23	Press wheel face by hand			129.3	.0013
Y-3	Dress face of grinding wheel with carborundum "stick"			129.3	
K-24	Mount face plate, chuck or fixture			9667.2	.0967
G-2	Lock and unlock workhead spindle	71.2x4		284.8	
S-3	Wipe object off with cloth	163.4x2		326.8	
R-3	Blow off part with air	117.4x12		1408.8	
Z-3	Obtain and lay aside chuck removing board			397.8	
L-1	Put chuck, fixture or face plate on spindle nose			156.1	
P-4	Place bolt in chuck, fixture or face plate & run in	414.0x6		2484.0	
R-4	Tighten bolt in chuck, fixture or face plate with wrench	211.9x12		2542.8	
E-2	Place each washer on bolt	56.2x6		337.2	
G-4	Pick up and lay aside tool	67.1x6		402.6	
T	Turn workhead spindle by hand	58.1x20		1162.0	
K-6	Obtain and lay aside on bench			164.3	
K-25	Remove chuck, fixture or face plate			4992.7	.0499
M-1	Remove chuck, fixture or face plate from spindle nose			95.8	
G-2	Lock and unlock workhead spindle	71.2x2		142.4	
R-4	Loosen bolt in chuck, fixture or face plate with wrench	211.9x6		1271.4	
Q-4	Run cut bolt in chuck, fixture or face plate and lay aside	322.9x6		1937.4	
Z-3	Obtain and lay aside chuck removing board			397.8	
K-6	Obtain and lay aside tool on bench			164.3	
T	Turn workhead spindle by hand	58.1x10		581.0	
G-4	Pick up and lay aside tool	67.1x6		402.6	
K-26	Mount 3 jaws in chuck			12062.1	.1206
D-1	Mount and remove one chuck jaw	75.6x3		226.8	
T	Turn workhead spindle by hand	58.1x12		697.2	
S-2	Wipe small object off with cloth	110.0x9		990.0	
K-3	Use one screw	626.6x12		7519.2	
G-1	Grease one jaw in 3 jaw chuck	125.5x3		376.5	
R-1	Open and close chuck jaws	123.4x3		370.2	
K-6	Obtain and lay aside tool on bench	164.3x3		492.9	
E-4	Additional to tighten and loosen screw with allen wrench	132.0x9		1188.0	
G-4	Pick up and lay aside tool	67.1x3		201.3	

FORMULA GR-2

	SYNTESIS (Cont'd)	TMU	Dec Hours
K-27	Set-up 3 jaw chuck	71859.0	.7186
K-24	Mount chuck	9667.2	
K-26	Mount 3 jaws in chuck	12062.1	
K-28	Grind jaws	37042.4	
Q-1	Set pressure of chuck	411.3	
K-20	Set-up wheelhead	12676.0	
K-28	Grind jaws	37042.4	.3704
H-1	Place spider in chuck and remove	354.8x6	2128.8
R-1	Open and close chuck jaws	123.4x9	1110.6
K-22	Con.**ant per piece (S.M.P.)	660.2x8	5281.6
	Check dia. of jaws (GAU-1(K-26)	440.0x8	3520.0
	Grind jaw time (average) Est		16700.0
U-4	Scrn sharp edges of 3 jaws		1262.4
T	Turn workhead spindle by hand	58.1x3	174.3
K-32	Dress dia. of wheel with diamond	803.3x5	4016.5
L-2	Adjust spider to size (S.M.P.)	73.8x6	442.8
K-41	Place part in chuck (S.M.P.)	365.3x2	730.6
U-1	Obtain and lay aside part	116.4x2	232.8
K-9	Use indicator	435.2x2	870.4
Y	Read indicator	90.1x2	180.2
S-4	Move indicator to part	70.0x2	141.6
V-3	Wipe off holding surface of 3 jaw chuck 58".8x2		117.6
T-1	Place and remove part from 3 jaw chuck 66".1x2		132.2
K-29	Set-up coolant	1416.0	.0162
Z	Position coolant pipe	78.7x2	157.4
A-1	Adjust coolant flow	131.2x2	262.4
G	Walk to side of machine and return	294.2x2	588.4
G-4	Pick up and lay aside tool		67.1
D-2	Tighten or loosen each nut with wrench 88.2x2		176.4
K-6	Obtain and lay aside tool on bench		164.3
K-30	Set-up truing unit	12509.1	.1251
N-2	Insert and remove diamond in holder		102.8
P-2	Set truing unit for automatic diamond rise		309.9
		103.3x3	
R-2	Move truing unit forward or back	113.1x2	226.2
S-2	Move truing unit base		216.4
D-2	Tighten or loosen each nut with wrench 88.2x32		2822.4
S-3	Wipe small object off with cloth	110.0x2	220.0
H	Walk to rear of machine and back	397.2x7	2780.4
K-22	Operate machine each dimension	660.2x6	3961.2
K-6	Obtain and lay aside tool on bench	164.3x3	492.9
G-4	Pick-up and lay aside tool	67.1x6	402.6
K-3	Use one screw		626.6

FORMULA GR-2

	SYNTHESIS (Cont'd)	TMU	Dec Hours
K-31	Align workhead	21382.7	.2138
C-3	Swivel workhead to adjust taper of work	117.4x4	469.6
K-32	Dress diameter of wheel with diamond	803.3x5	4016.5
G-4	Pickup and lay aside tool	67.1x5	335.5
D-2	Tighten or loosen each nut with wrench	88.2x32	2822.4
B-3	Swivel work 1/2" taper per foot		296.6
H	Walk to rear of machine and return	397.2x5	1986.0
K-9	Use indicator	435.2x4	1740.8
K-22	Operate machine each dimension	660.2x5	3301.0
K-6	Obtain and lay aside tool on bench		164.3
	Clean-up grind time average (est)	600.0x5	3000.0
	Check taper with gage (GAU-1(K-49)	650.0x5	3250.0
K-32	Dress diameter of wheel with diamond	803.3	.0080
K-3	Reverse table travel by hand	35.2x3	105.6
L-3	Move wheelhead cross slide	90.3x2	180.6
T-2	Lower truing diamond by hand		57.9
W-1	Set table traverse speed	54.6x2	109.2
	Wheel dress time (average)	est.	350.0
K-33	Set-up machine	57634.8	.5763
K-20	Set-up wheelhead	12676.0	
K-31	Align workhead	21382.7	
K-29	Set-up coolant	1416.0	
K-30	Set-up truing unit	12509.1	
G	Walk to side of machine and return	7451.6	
J	Turn master switch on or off	90.2x2	180.4
H	Walk to rear of machine and return	397.2x2	694.4
H-3	Mount & remove front or rear splash guard	204.7x2	409.4
R	Turn wheelhead or hydraulic motor on or off	112.7x4	450.8
P-3	Open or close air supply for hose	159.8x2	319.6
Y-1	Set workhead spindle speed	144.8	144.8
K-34	Set-up face plate	19652.6	.1965
K-24	Mount face plate	9667.2	
K-25	Remove chuck, fixture or face plate	4992.7x2	9985.4
K-35	Set-up fixture	21326.8	.2133
K-34	Set-up fixture (S.M.P.)	19652.6	
K-10	True-up object with indicator		1674.2

FORMULA GR-2

	SYNTHESIS	TMU	Dec Hours
K-36	Assemble (3) chuck finger stops	14769.3	.1477
E-1	Walk to vise and return	1537.2	
	Use vise- (Form. F-2(K-8)	243.5x6	1461.0
K-3	Use one screw	626.6x3	1879.8
	Use 6" scale- (Form GAU-1(K-2)	250.0x6	1500.0
D-2	Tighten or loosen each screw	88.2x6	529.2
G-4	Pick up and lay aside tool	67.1x9	603.9
K-5	Obtain tools from tool box		647.4
K-7	Obtain tools in cabinet		6610.8
K-37	Set-up finger back stops in chuck	28412.9	.2841
K-36	Assemble (3) chuck finger stops	14769.3	
	Use 6" scale (For. GAU-1 (K-2)	250.0	
S-3	Wipe large object off with cloth	163.4x3	490.2
S-3	Wipe small object off with cloth	110.0x3	330.0
F-1	Mount one finger back stop	1204.2x3	3612.6
J-1	Reposition one finger back stop	54.2x6	325.2
T-4	Remove one finger back stop	306.9x3	920.7
K-6	Obtain and lay aside tool on bench	164.3x2	328.6
T	Turn workhead spindle by hand	58.1x12	697.2
G-4	Pick up and lay aside tool	67.1x3	201.3
K-22	Operate machine each dimension		660.2
R	Turn wheelhead motor on or off	112.7x2	225.4
	Wait for wheelhead to stop EST		700.0
S	Turn workhead spindle on or off with turn button	34.6x4	138.4
F-3	Move table by hand		153.3
E-4	Additional to tighten and loosen screw with allen wrench	132.0x3	396.0
K-3	Use one screw	626.6x3	1879.8
R-1	Open and close chuck jaws	123.4x2	246.8
	Clean up grind fingers of stops EST		1700.0
K-23	Dress wheel face by hand	129.3x3	387.9
K-38	Set up radius dresser	32299.4	.3230
C-4	Remove and replace diamond holder unit	86.2	
D 4	Mount and remove radius dresser	88.2	
K-39	Dress radius of wheel with radius dresser	7408.0	
		740.8x10	
F-4	Set radius on radius dresser	38.5x10	385.0
K-3	Use one screw	626.6x8	5012.8
G-4	Pick up and lay aside tool	67.1x20	1342.0

FORMULA CR-2

	SYNTHESIS (Cont'd)	TMU	Dec Hours
K-38	(Cont'd)		
D-2	Tighten or loosen each screw with wrench 88.2x11	970.2	
K-6	Obtain and lay aside tool on bench 164.3x11	1807.3	
J-3	Move wheelhead cross slide 163.3x4	653.2	
U-3	Set stop on wheelhead cross slide handwheel	224.5	
S-3	Wipe small object off with cloth 110.0x2	220.0	
K-22	Operate machine each dimension 660.2x10	6602.0	
	Clean up grind (average) EST 300.0x10	3000.0	
	Use radius gauge GAU-1 (K-24) 450.0x10	4500.0	
K-39	Dress radius of wheel with radius dresser	750.8	.0074
L	Move wheelhead cross slide 90.3x2	180.6	
T-2	Raise or lower truing diamond by hand 57.9x2	115.8	
E-3	Reverse table travel by hand	35.2	
W-1	Set table traverse speed 54.6x2	109.2	
	Dress time (average) EST	300.0	
K-40	Use air chuck	304.9	.0030
S-1	Open and close chuck jaws (air)	63.0	
T-1	Place and remove part from 3 jaw chuck	66.1	
V-3	Wipe off holding surface of 3 jaw chuck	58.8	
R-3	Blow off part with air	117.0	
K-41	Use spring chuck	365.3	.0037
R-1	Open and close chuck jaws (spring)	123.4	
T-1	Place and remove part from 3 jaw chuck	66.1	
V-3	Wipe off holding surface of 3 jaw chuck	58.8	
R-3	Blow off part with air	117.0	
K-42	Use magnetic chuck	2293.0	.0229
K-10	True-up object with indicator	1674.4	
C-1	Turn chuck magnet on and off	211.8	
M-4	Mount and remove part or fixture from magnetic chuck	80.2	
S-3	Wipe large object off with cloth 163.4x2	326.8	
K-43	Handle part 5# and under	350.1	.0035
U-1	Lay aside and obtain new part	116.4	
R-3	Blow off part (air)	117.0	
G-3	Raise and lower workhead guard	116.7	
K-44	Handle part over 5#	500.1	.0050
H-4	Lay aside and obtain new part	266.4	
R-3	Blow off part (air)	117.0	
G-3	Raise and lower workhead guard	116.7	

FORMULA GR-2

SYNTHESIS
(Cont'd)

		<u>TMU</u>	<u>Dec. Hours</u>
K-45	Set-up fixture on magnetic chuck	<u>2559.4</u>	<u>.0256</u>
K-42	Use magnetic chuck	2293.0	
H-4	Lay aside and obtain new part (Sim.Mot.Pat)	266.4	
K-46	Deburr sharp edge	<u>172.7</u>	<u>.0017</u>
N-4	Deburr sharp edge with stone	172.7	
K-47	Deburr each additional sharp edge	<u>83.0</u>	<u>.0008</u>
N-4	Deburr each additional sharp edge with stone	83.0	
K-48	True-up part in fixture with adjusting screws	<u>4450.8</u>	<u>.0445</u>
K-9	Use indicator	435.2	
S	Turn workhead spindle with job button 34.6x2	69.2	
T	Turn workhead spindle by hand. 58.1x6	348.6	
Y	Read indicator 90.1x6	540.6	
V-4	Tighten and loosen thumb screw hand tight 107.0x7	749.0	
K-49	Supervisor's first piece approval	<u>11521.4</u>	<u>.1152</u>
A	Walk to supervisor's desk and return (without instructions)	1387.2	
G-4	Pick up and lay aside blue print or piece part 67.1x2	134.2	
L	Time for supervisor to study blueprint and operation sheet	5000.0	
GAU-1	Time to check each dimension (average) 1000.0x5	5000.0	
K-50	Set-up workhead on extended bridge	<u>16440.6</u>	<u>.1644</u>
X-4	Move workhead on extended bridge 36" (aver.) 1222.7x2	2445.4	
K-6	Obtain and lay aside tool on bench 164.3x4	657.2	
D-2	Tighten or loosen each nut with wrench 88.2x32	2822.4	
V-4	Tighten or loosen nut by hand (S.M.P.) 107.0x32	3424.0	
G-4	Pickup and lay aside tool 67.1x12 805.2		
S-3	Wipe object off with cloth Large object 163.4x8	1307.2	
R-4	Tighten or loosen nut on workhead (S.M.P.) 211.9x16	3390.4	
H	Walk to rear of machine & return 397.2x4	1588.8	

FORMULA GR-2

SYNTHESIS
(Cont'd)

		<u>TMU</u>	<u>Dec.</u>	<u>Hours</u>
K-51	Set-up steadyrest on extended bridge	11387.7	.1139	
Y-4	Mount steadyrest on bridge & remove	700.0		
K-6	Obtain and lay aside tool on bench 164.3x4	657.2		
D-2	Tighten or loosen each nut with wrench 88.2x30	2646.0		
V-4	Tighten or loosen nut by hand (S.M.P.) 107.0x4	428.0		
G-4	Pickup and lay aside tool	67.1x5	335.5	
S-3	Wipe large object off with cloth	163.4x2	326.8	
R-3	Blow off part with air	117.0x2	234.0	
R-4	Tighten or loosen nut on steadyrest (S.M.P.)	211.9x4	847.6	
Z-4	Set one steadyrest jaw to part	406.0x3	1218.0	
A-5	Adjust one steadyrest jaw to part	268.9x10	2689.0	
K-9	Use indicator	435.2x3	1305.6	
K-52	Use steadyrest on extended bridge	365.2	.0037	
W-4	Close & open steadyrest on extended bridge	365.2		
K-53	Additional set-up for extended bridge	29654.3	.2965	
K-50	Set-up work head	16440.6		
K-51	Set-up steadyrest	11387.7		
K-52	Use steadyrest	365.2x5	1826.0	

FORMULA CR-2

SECTION IV

TABLE OF ELEMENTS AND METHODS ANALYSIS SHEETS

ORIGINAL COPY WAS OF POOR QUALITY.
THIS IS A BETTER REPRODUCTION.
NOT FURNISHED.

FORMULA CR-2

TIME OF MATERIAL

	TIME
A Walk to supervisor's desk or timekeeper and return	4387.2
B Walk to tool box and return	12637.2
C Walk to cabinet and return	2337.2
D Walk to wheelhead storage rack and return	3237.2
E Clean and replace wheelhead at storage rack	344.2
F Clean and replace tool in cabinet	99.0
G Walk to side of machine and return	294.2
H Walk to rear of machine and return	39.2
J Turn master switch on or off	90.2
L Study blueprint and operation sheet	5000.0
M Open and close cabinet doors	85.7
N Open and close tool box drawer	57.4
P Get tool from tool box and replace	63.0
Q To work bench and back	97.2
R Turn wheelhead, hydraulic or coolant motor on or off	112.7
S Turn workhead spindle with jog button	34.6
T Turn workhead spindle 1/4 turn by hand	58.1
U Adjust length of wheel guard	41.7
V Assemble indicator to surface gage	432.5
W Disassemble indicator from surface gage	225.6
X Set indicator to object	124.3
Y Read indicator	30.1
Z Position coolant pipe	78.7
 A-1 Adjust coolant flow	131.2
B-1 Turn chuck magnet on and off (electro magnet)	125.8
C-1 Turn chuck magnet on and off (permanent magnet)	211.8
D-1 Mount and remove one chuck jaw	75.6
E-1 Walk to vice and return	1537.2
F-1 Mount one finger back stop in chuck	1204.2
G-1 Grease one jaw of the 3 jaw chuck	125.5
H-1 Place spider on 3 jaw chuck and remove	354.2
J-1 Deposition on back stop in chuck	54.2
L-1 Put chuck fixture or face plate on spindle base	156.1
M-1 Remove chuck, fixture or face plate from spindle base	95.8
N-1 Open or close air chuck valve	165.0
P-1 Set air chuck pressure	144.1
Q-1 Set pressure of 3 jaw chuck	411.3
R-1 Open and close chuck jaws on chuck	123.4
S-1 Open and close chuck jaws on chuck	63.0
T-1 Place and remove part from 3 jaw chuck	66.1
U-1 Lay aside and obtain new part 54 end under.	116.4
V-1 Set workhead spindle speed	144.8
W-1 Set table traverse speed hydraulic	54.6
X-1 Run down each part by hand	79.2

FORMULA CR-2

TABLE OF ELEMENTS
(continued)

	TIME
A-2 Move each screw to hole and engage	115.7
B-2 Turn down each screw by hand	162.1
C-2 Turn out each screw by hand and lay aside	176.8
D-2 Tighten or loosen each screw or nut with wrench	88.2
E-2 Place each washer on stud	96.2
F-2 Remove and lay aside each washer	44.6
G-2 Lock and unlock workhead spindle	71.2
H-2 Index barrel stop one position	153.0
J-2 Move one table reverse or stop dog 6"	217.2
L-2 Adjust one table reverse or stop dog	73.8
M-2 Raise or lower stop dog tongue	64.5
N-2 Insert and remove diamond in holder	102.8
P-2 Set truing unit for automatic diamond rise	115.9
Q-2 Set trip for automatic diamond rise	103.3
R-2 Move truing unit forward or back 3"	113.1
S-2 Move truing unit base 3"	216.4
T-2 Raise or lower truing diamond by hand	37.9
U-2 Mount and remove wheelhead	413.6
V-2 Place shim under wheelhead	118.1
W-2 Remove shim from under wheelhead	69.8
X-2 Block wheelhead spindle to remove and mount quill	212.3
Y-2 Mount and remove grinding wheel on quill	239.4
Z-2 Mount and remove wheelhead drive belt	208.4
 A-3 Tighten and loosen wheelhead drive belt	140.8
B-3 Swivel workhead for 1/2" taper per foot	295.6
C-3 Swivel workhead to adjust cap or align load	117.4
D-3 Raise and lower grinding wheel guard by hand	300.0
E-3 Reverse table traverse by hand	38.2
F-3 Move table by hand one-half foot	153.3
G-3 Raise and lower workhead guard	136.7
H-3 Mount and remove front or rear splash guard	204.7
J-3 Move wheelhead cross slide (Set up)	163.3
L-3 Move wheelhead cross slide (operation)	90.3
M-3 Move workhead cross slide one-half inch	140.2
N-3 Move workhead cross slide 1/16" dial reading	86.5
P-3 Open or close air supply for hose	159.8
Q-3 Tap object with hammer	102.3
R-3 Blow off part with air	117.0
S-3 Wipe object off with "on back" Small object	110.0
Ca-3 Wipe object off with "on back" Large object	163.4
T-3 Dress diameter of wheel with carburendum "stick"	451.4
U-3 Set stop on wheel head cross slide for wheel	224.5
V-3 Wipe off bolting surface of 3 jaws	58.8
W-3 Bring grinding wheel to face of work with facing attachment	62.7
X-3 Dress face of grinding wheel with carburendum "stick" on wheel	267.2
Y-3 Dress face of grinding wheel with carburendum "stick" (operator)	129.3
Z-3 Obtain and attach facing ring to wheel	397.8

ALL OPERATIONS WITH POOR QUALITY,
NOT FINISHED, PRODUCTION FROM

FORMULA CR-2

TABLE OF ELEMENTS

		<u>TIME</u>
A-4	Mount workhead guard	267.6
B-4	Remove workhead guard	181.2
C-4	Remove and replace diamond holder unit	86.2
D-4	Mount and remove radius dresser	88.2
E-4	Additional to tighten and loosen screw with Allen wrench	132.0
F-4	Set radius on radius dresser	38.5
G-4	Pick up and lay aside tool	67.1
H-4	Lay aside and obtain new part (over 5#)	266.4
J-4	Move workhead barrel stop unit to or from indicator	38.3
M-4	Mount and remove part or fixture on magnetic chuck	80.2
N-4	Deburr sharp edge with stone	172.7
	Each additional sharp edge	83.0
P-4	Place bolt in chuck, fixture or face plate and run in	414.0
Q-4	Run out bolt in chuck, fixture or face plate and lay aside	322.9
R-4	Tighten or loosen bolt in chuck, fixture or face plate with wrench	211.9
S-4	Move indicator to part	70.8
T-4	Remove one finger back stop in chuck	306.9
U-4	Stone sharp edges of 3 jaws	1262.4
V-4	Tighten and loosen thumb screw hand tight	107.0
W-4	Close & Open extended bridge steadyrest	365.2
X-4	Move workhead on extended bridge 36"(average)	1222.7
Y-4	Mount steadyrest on extended bridge & remove	700.0
Z-4	Set one steadyrest jaw to part	406.0
A-5	Adjust one steadyrest jaw to part	268.9

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description Right Hand
A Walk to supervisor's desk or timekeeper and return						
		18.6	TBC1			To supervisor
		675.0	W45P			Receive instructions
		5000.0	EST			
		18.6	TBC1			
		675.0	W45P			Return
		6387.2				
Without instructions			1387.2			
B Walk to tool crib and return						
		18.6	TBC1			To tool crib
		2100.0	W140P			Wait for service
		8400.0	EST			
		18.6	TBC1			
		2100.0	W140P			return
		12637.2				
C Walk to cabinet and return						
		18.6	TBC1			To cabinet
		300.0	W20P			Search & select
		1700.0	EST			
		18.6	TBC1			
		300.0	W20P			Return
		2337.2				
D Walk to wheelhead storage rack and return						
		18.6	TBC1			To storage area
		750.0	W50P			Search & select
		1700.0	EST			
		18.6	TBC1			
		750.0	W50P			Return to machine
		3237.2				
E Obtain & replace wheelhead at storage rack						
		29.0	B			
		14.4	145			Get wheelhead
		2.0	GIA			
		27.8	M1472			
		31.9	AB			
		37.2	TBC1			
		27.8	M14825			
		2.0	RL1			
		2.0				
Replace		172.7				
		244.7				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.M.U	R.H.	No.	Description-Left Hand
F Obtain and replace tool in cabinet						
Replace	74.4	R28B				To tool
	2.0	G1A				
	23.1	M28B				Tool from cabinet
	<u>49.5</u>					
Replace	49.5					
	<u>49.5</u>					
	50.0					
G Walk to side of machine and return						
	18.6	TBC1				
	135.0	W12P				To side of machine
	18.6	TBC1				
	<u>135.0</u>	W12P				
	294.2					
H Walk to rear of machine and return						
	18.6	TBC1				
	180.0	W12P				To rear of machine
	18.6	TBC1				
	<u>180.0</u>	W12P				
	397.2					
J Turn master switches on or off						
To switch	B	29.0				
	G1A	2.0				
Open or close	M3A	4.9				
	RL1	2.0				
To 2nd switch	R10B	11.5				
	G1A	2.0				
Open or close	M3A	4.9				
	RL1	2.0				
	AB	<u>31.9</u>				
	90.2					
L Study blueprint and operation sheet						
	5000.0	EST				
M Open and close cabinet door						
Same motion pattern	8.7	R10A				To door handle
	2.0	G1A				
	23.1	M28B				Open door
	2.0	RL1				
	24.4	R28B				To door
	.0	G5				
	25.5	M28A				Close door
	<u>.0</u>	RL2				
	85.7					

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	R.H.	No.	Description-Right Hand
N Open and close tool box drawer						
		15.8	R16B			To drawer
		2.0	G1A			Open
		8.9	M6B			To drawer
		2.0	RL1			Close
		6.4	R4B			To balance
Same motion pattern		.0	G5			
		8.1	M6A			
		.0	RL2			
		14.2	R16E			
		<u>57.4</u>				
P Get tool from tool box and replace						
		12.9	R12B			To tool
		9.1	O4B			
		13.4	M12B			Tool to body
		15.2	M12C			Tool to drawer
		10.4	PL18E			Lay in drawer
		2.0	RL1			
		<u>63.0</u>				
Q To work bench and back						
		18.6	TBC1			To bench
		30.0	W2P			
		18.6	TBC1			To machine
		30.0	W2P			
		<u>97.2</u>				
R Turn wheel head, hydraulic or coolant motor on or off						
		SS18C1	20.6			
To button		B	29.0			
		R16B				
		G5	.0			
Push button		AP2	10.6			
		RL2	.0			
		AB	31.9			
To balance		SS18C1	<u>20.6</u>			
			<u>.7</u>			
S Turn workhead spindle with jog button						
To jog button		R18D	18.4			
		G5	.0			
Push button		AP1	16.2			
		RL2	.0			
			<u>34.6</u>			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.N.	TNU	R.N.	No.	Description-Right Hand
T Turn workhead spindle one-quarter turn by hand						
To spindle	R24B	21.5				
	G1A	2.0				
Turn spindle	M12C10	20.8				
	KL1	2.0				
To balance	R12E	11.8				
		<u>58.1</u>				
U Adjust length of wheel guard						
	12.9	R12B				To guard
	2.0	G1A				
	8.0	MFC	4			Lengthen or shorten
	16.8	G2	3			
	2.0	KL1				
	<u>41.7</u>					
V Assemble indicator to surface gage						
To surface gage	R16B	15.8				
	G1A	2.0				
Gage to work area	M16B	15.8				
	G2	5.6				
	11.5	R10B				To surface gage arm
	2.0	G1A				
Hold surface gage base	AP1	16.2				
	1.8	MSC				Swing arm up
	2.0	KL1				
	11.5	RSD				To indicator holder
	2.0	G1A				screw
	16.2	AP1				
	8.0	MFB	4			Loosen screw
	22.4	G2	4			
	KL1	2.0	KL1			
To indicator	R16B	15.8				
	G1A	2.0				
To work area	M16B	15.8				
Hold	G2	5.6				
	11.5	RSD				To indicator arm
	2.0	G1A				lock screw
	16.2	AP1				
	4.0	MFB	2			Loosen lock screw
	11.2	G2	2			
	8.0	MFC				Swing indicator arm
	11.2	G2	2			
	4.0	MFB	2			Tighten lock screw
	16.2	AP1				
To indicator holder	KL1	2.0				
	RSD	1.5				
	G1A	2.0				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	R.H.	No.	Description-Right Hand
V (continued)						
Align holes in holder	{ 2	API	32.4			
		MFC	2.0			
			13.5	M10C		To indicator holder
			21.8	P20D		
			3.4	M1C		Into holder
			5.2	M2C		Swing to position
			5.6			
Tighten indicator holder	{ 4	G2				
		MfB	8.0			
	{ 4	G2	22.4			
	{ 2	API	32.4			
		RL1	2.0			
			432.5			
W Disassemble indicator from surface gage						
To indicator holder		R16B	15.8	R16B		To indicator
			2.0	G1A		
Loosen screw	{ 4	API	16.2			
		MfB	8.0			
	{ 4	G2	22.4			
			7.5	D2E		Remove indicator arm
			16.9	M4B		
			2.0			
To indicator		RL1				
		R4B	6.4			
		G1A	2.0			
			5.6	G2		
			16.2	AP1		Loosen indicator
			2.9	M1B		
			2.0	RL1		
			4.0	R2B		
			2.0	G1A		Swing Indicator arm
			4.6	M2B		
			5.6			
			2.0	RL1		
			4.0	R2B		To screw
			2.0	C.A		
			2.9	M1B		Tighten screw
			16.1	AP1		
		RL1	2.0			
			15.8	M16B		Lay indicator aside
			2.0	RL1		
To surface gage base	R16B	15.8	R16B			To surface gage arm
	G1A	2.0	G1A			
Hold	API	16.2				
		10.6	M2B			
	RL1	2.0	RL1			Fold arm
		225.6				

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
X Set indicator to object						
Set indicator on table and hold M12C	15.2					
	8.6	R6B				To surface, gage arm
	2.0	G1A				
	11.8	M8C				Swing down
	2.0	RL1				
	10.1	R6D				To indicator
	2.0	G1A				
	16.2	P2SE				Align indicator to object
	2.0	RL1				
	5.9	R2D				To dial
	7.3	G1C1				
	5.2	M2C				
	16.2	P2SE				Turn dial to line
	7.3	EF				
	2.0	RL1				
	10.5	R10E				
	124.3					
Y Read indicator						
	29.2	EF			4	Read indicator
	60.0	E1T				
Z Position coolant pipe						
	12.3	R12B				To pipe
	2.0	G1A				
	16.2	A14				
	12.0	M10L	6			
	33.6					Move pipe
	2.0	R1	6			
	78.7					

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
A-1 Adjust coolant flow						
			15.8	R16B		Valve
			2.0	G1A		
			32.4	AP1	2	Increase or decrease flow
			4.0	M1C	2	
			75.0	EST		Flow time
			2.0	RL1		
			131.2			
B-1 Turn chuck magnet on and off (electro magnet)						
To switch			R24B	21.5		
			G1A	2.0		
Turn on			M3A	4.9		
			RL1	2.0		
To balance			R24E	19.2		
To switch			R24B	21.5		
			G1A	2.0		
Turn off	3	M3C	20.1			
	2	M3B	11.4			
		RL1	2.0			
To balance			R24E	19.2		
			125.8			
C-1 Turn chuck magnet on and off (permanent magnet)						
			15.7	M16C		Wrench to chuck
			3.6	P1SE		
			19.7	P2SSE		Wrench in socket
			5.6	G2		
			9.0	M2B10		
			2.0	RL1		
			8.4	R4D		
			2.0	G.A		
			11.6	M4B10		
			7.5	R2E		Remove wrench
			15.8	M6B		To body
			10 ^c 9			
Turn off			10 ^c 9			
			211.9			
D-1 Mount and remove one chuck jaw						
			12.9	P1B		To jaw
			2.0	G1A		
			17.6	M18A		Jaw to chuck
			2.5	M1A		
			3.4	M1C		Align jaw
			16.2	P1SE		
			2.0	RL1		
			17.0	M18B		Position holes
			2.0	RL		
			75.6			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
E-1 Walk to vise and return						
			18.6	TBC1		
			750.0	WSOP		To vise
			18.6	TBC1		
			750.0	WSOP		Return
			<u>1537</u>	<u>2</u>		
F-1 Mount one finger stop in chuck						
To screw . .		R14B	15.8	R16B		To stop
		G1A	2.0	G1A		
Screw to stop		M8C	11.8			
Screw through		P1SE	5.6			
Stop		M2A	3.6			
		RL1	2.0			
			18.7	M16C		Stop to chuck
			750.0	EST		Time for positioning
						in obstructed area
To stop		R16D	17.0			
Holi		G1A	2.0			
			2.0	RL1		
			15.8	R16B		To wrench
			2.0	G1A		
			18.7	M16C		Wrench to screw
			25.3	P2SSD		
			5.6	G2		Hold
		RL1	2.0			
To nut		R16B	5.8			
		G1A	2.0			
Nut to chuck		M14C	16.9			
Nut to screw	3	G2	16.8			
	3	M16C	6.0			
		P2SSD	21.8			
			58.0	M B	20	
			40.0	RL	20	Tighten
			47.5	R1B	4	
			38.0	G1A	9	
			16.2	AF		
		RL	7.5	E2E		
			15.8	M 6B		La. aside
			2.0	RL		
			<u>204</u>	<u>2</u>		
G-1 Grease one jaw on the 3 jaw chuck						
		M16C	18.7	M16C		Grease gun to chuck
		P2SSD	21.8	P2SSD		Grease gun to fitting
Hold grease gun		G2	5.6	G2		
			36.0	M2A ^E	6	Pump grease
			~ 6	M1B	6	
		M16B	~ 2	M 6B		Gun to body
			<u>125</u>	<u>2</u>		

FORMULA GR-2
METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
H-1 Place spider in 3 jaw chuck and remove						
To spider	R10D	12.9		22.1	M20C	Spider to chuck
	G3	5.6		52.1	P3SSD	
		5.9		20.4	M1C	6 } Into chuck
		2.0		33.6	G2	6 }
To balance	RL1	2.0				
	R10E	10.5				
		2.0		RL1		
		11.8		R'2E		To balance
		14.2		R12D		To spider
		2.0		G1A		
		52.1		P3SSD		Remove spider
		20.4		M1C	6 }	
		28.0		G2	5 }	
		18.2		M20B		To body
			354.8			
J-1 Reposition one back stop in chuck						
	10.1	R6D				To stop
	2.0	G A				
	10.2	M1C	3			Reposition
	21.9	EF	3			Look
	2.0	RL1				
	8.0	R6F				To balance
	14.2					
L-1 Put chuck, fixture or face plate on spindle nose						
Same action pattern	31.0	M20B30				IC board on bed
	5.6	G2				
	6.	AF				
	17.0	M1C30				Mount on spindle nose
	5.6	G2				
	0.7	M1C	3			Align holes
	8	F2SD				
	5.6	G2				
	16.1	AP				Seat against nose
	2.0	RL1				
	156.1					

FORMULA CR-2
METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
M-1 Remove chuck, fixture or face plate from spindle nose						
Same motion pattern		5.6	G2			
		33.4	M18B30			To board on bed
		5.6	G2			
		16.2	AP1			
		35.0	M20B30			To body
		95.8				
N-1 Open or close air chuck valve		29.0	S			
		12.9	R12B	5		To valve
		10.0	G1A	5		
		40.0	M5B	5		Open or close
		10.0	R11	5		
		31.2	R5B	4		
		31.9	AS			
		165.0				
P-1 Set air chuck pressure		29.0	S			To valve
		10.0	G1A	5		
		27.0	T90S	5		Open or close valve
		10.0	R11	5		
		21.6	T90S	4		
		14.6	EF	2		Look at pressure gauge
		21.7	AS			
		44.1				
Q-1 Set pressure of spring chuck		8.7	M10C			Rod to tension nut
		10.6	P2SD	6		Rod into hole of nut
		36.6	G1	6		
		140.4	M10B10	6		Turn nut
		37.1	R12F	6		
		67.5	M10C			To other hole
		5.8	M4B			Rod to body
		141.3				
R-1 Open and close chuck jaws (spring chuck)						
		SS12C1	17.0			
To lever		R12B	10.1			
Open jaws		M10A10	16.4			
		R11	2.0			
To balance		SS12C1	17.0			
To lever		R12B	12.9			
		G1A	2.0			
		SS12C1	17.0			
Close jaws		M10C				
		R11	2.0			
To balance		SS12C1	17.0			
			133.4			

METHODS ANALYSIS CHART

FORMULA CR-2

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
S-1 Open and close chuck jaws (air chuck)						
To valve lever	R20B	18.6				
	G.A	2.0				
Open	M6B	8.9				
	RL1	2.0				
		<u>31.5</u>				
Close		<u>31.5</u>				
		<u>63.0</u>				
T-1 Place and remove part from 3 jaw chuck						
	8.0	M4C				Part to chuck
	16.2	F2SE				
	6.7	M3C				Into chuck
	5.6	G2				
	2.0	MFC				
	2.0	RL1				
	15.7	R20E				To balance
		<u>32.00</u>				Limited out by
	2.0	G.A				Element R-1
	6.9	M4B				Remove part
	<u>66.1</u>					
U-1 Lay aside and obtain new part under S-1						
	10.8	M4B				To body
	18.6	T5				
	14.6	M4B				Lay in box
	2.0	RL				
	14.4	RL4				To another part
	2.0	G.A				
	4.6	M4C				Remove part
	18.6	B1				
	15.2	RL1				To holding device
	<u>64.4</u>					
V-1 Set workhead spindle speed						
	SS15C	38.1				
To switch button	R4D	4.6				
	G5	.0				
Open contact	AP1	10.6				
	RL2	.0				
To knob	R5B	7.8				
	G.A	2.0				
Turn knob	M4C	8.0				
	G2	5.6				
Close contact	AP2	10.2				
	RL1	2.0				
To balance	SS 60C	19.1				
		<u>44.8</u>				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	R.H.	No.	Description-Right Hand
-----------------------	-----	------	-----	------	-----	------------------------

W-1 Set table traverse speed (hydraulic)

15.8	R16B			To traverse lever
2.0	G1A			
7.8	R5B			
16.8	G2	3		With thumb
10.2	M1C	3		Adjust speed
2.0	KL1			
				34.6

X-1 Run down each nut by hand

20.0	R2B	5	
10.0	G1A	5	
23.0	M2B	5	Run down nut
16.2	AP1	5	Hand tighten
10.0	KL1	5	
			79.2

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
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A-2 Move each screw to hole and engage

15.8	R16B		To screw
2.0	G1A		
18.7	M16C		To hole
5.6	P1SE		
8.0	M4C		To thread
16.2	P2SE		
18.4	M2B	4	
8.0	RL1	4	
12.0	R2B	3	
6.0	G1A	3	
		110.7	

B-2 Run down each screw by hand

30.0	G1A	15	Turn screw
46.4	M1B	16	
37.5	R1B	15	
16.2	AP1		
32.0	RL1	16	
		162.1	

C-2 Run out each screw b. hand and lay aside

1.5	R10B		To screw
31.0	G1A	16	
46.4	M1B	16	Run out
32.0	RL1	16	
37.5	R1B	15	
4.0	D1E		Remove screw
12.4	M12B		Lay aside
2.0	RL.		
		179.8	

D-2 Tighten or loosen each screw or nut with wrench

11.7	M9C		Wrench to screw
14.7	P2SSE		On screw
37.4	AP1	2	Tighten or loosen
13.8	M4B	2	
5.6	G2		
4.0	D1E		
		68.2	

E-2 Place each washer on stud

15.8	R16B		To washer
3.5	G1B		
18.7	M16C		Washer to stud
16.2	P2SE		
2.0	RL		
		59.1	

FORMULA CR-2
METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
-----------------------	-----	------	-----	------	-----	------------------------

P-2 Remove and lay aside each washer

	15.8	R16B	To washer
	3.5	G1B	
	7.5	D2E	Remove
	15.8	M16B	Lay aside
	<u>2.0</u>	RL1	
	<u>44.6</u>		

G-2 Lock and unlock workhead spindle

To lock pin	R16D	17.0	
	G5	.0	
Lock spindle	{		
	AP2	10.6	
	M1A	2.5	
	RL2	.0	
To lock pin	R16D	17.0	(R16D)
	G1A	2.0	G1A
		9.7	M2C10
	M1B	2.9	
	D2E	7.5	
	RL1	<u>2.0</u>	RL1
		<u>71.2</u>	

H-2 Index barrel stop one position

	40.7	SS18C2	
	29.0	B	
	<u>R16D</u>		To barrel stop
	2.0	G1A	
	6.7	M3C	Index
	2.0	RL1	
	31.9	AB	
	<u>40.7</u>	SS18C2	To balance
	<u>153.0</u>		

FORMULA CR-2
METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.M.	R.H.	No.	Description-Right Hand
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J-2 Move one table reverse or stop dog

To adjusting screw	12.9	R12B	5	To lock screw	
	10.0	G1A		Loosen	
	16.2	AP1			
	14.5	M1B			
	10.0	RL1			
	10.0	R1B		To dog	
Disengage	11.5	(12)	3		
	G1A	G1A			
	D2E	7.5			
	M1A	2.5		Move dog 6"	
Engage adjusting screw	21.3	M2B5	2		
	11.2	G2			
	G2	5.6	4		
	M1C	3.4		To lock screw	
	AP2	10.6			
	RL1	2.0			
		5.3			
		10.0			
		14.5			
		8.0		Tighten lock screw	
		10.0			
		16.2			
		2.0			
				RL1	
				217.2	

L-2 Adjust one table reverse or stop dog.

12.9	R12B	3	To adjusting screw
6.0	G1A		Turn screw
10.2	M1C		
6.0	RL1		
5.0	R1B		
2.0	EF		Look
	R2E		In balance
			3.2

M-2 Raise or lower stop dog tongue

10.6	SS1BC	2	To stop
14.4	R4B		
7.0	G1A		
4.4	M1A		Raise or lower tongue
7.0	RL		
20.6	SS1BC		To balance
			64.5

FORMULA CR-1

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TNU	R.H.	No.	Description-Right Hand
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B-2 Insert and remove diamond in holder

Diamond to holder	R20C	22.1
From holder	P2SE	16.2
	RL1	2.0
To balance	R20C	16.7
To diamond	R20B	18.6
	G1A	2.0
Remove	R20B	7.0
	R20B	18.2
		<u>102.0</u>

P-2 Set truing unit for automatic diamond rise

R20B	18.6	R20B	To arm	
G1A	2.0	G1A		
3	AP1	48.6	AP1	3 } To position
3	NFC	6.0	NFC	3 }
3	G2	16.8	G2	3 }
		21.9	RF	3 }
	RL1	2.0	RL1	
				<u>115.0</u>

Q-2 Set trip for automatic diamond rise

29.0	B		
12.0	R12B	To trip	
2.0	G1A		
8.7	R12B	3 } Move trip 3"	
16.0	G2	3 }	
2.0	RL1		
<u>31.9</u>	AB	To balance	
<u>103.3</u>			

B-2 Move truing unit forward or back 3"

R22B	20.1	R22B	To balance	
G1A	2.0	G1A		
2	AP1	32.4	AP1	2 }
2	NFC	4.0	NFC	2 }
	M3C5	9.3	M3C5	Move 3"
	G2	5.6	G2	
	P2SE	9.7	P2SE	A. 3"
	RL1	1.0	RL1	
	R21E	9.0	R21E	To balance
		<u>43.1</u>		

FORMULA CR-2

MOVEMENTS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.W.	R.H.	No.	Description-Right Hand
S-2 Move truing unit base 3"						
		21.5	R248			To truing unit base
		2.0	G1A			
		12.4	AP1	2		
		4.0	M2B	2		
		5.6	G2			
		20.6	M1C10			
To base		R298	16.6			
		G1A	2.0			
		5.6	G2			
	3	AP1	48.6	AP1	3	
	3	M1C10	23.1	M1C10	3	Move unit base 3"
	2	G2	11.2	G2	2	
		RL1	2.0	RL1		
		19.2	R248			
		216.4				To balance
T-2 Raise or lower wheel truing diamond (by hand)						
		22.9	R248			To lever
		2.0	G1A			
		6.1	M2A			Raise
		2.0	RL1			
		22.9	R302			To balance
		57.9				
U-2 Mount and remove wheelhead						
		12.9	R10D			To wheelhead
		2.0	G.A			
		16.2	AP1			
		40.2	M20C30			Wheelhead to machine
		5.6	G2			
		16.2	AP1			
		28.8	M10C30			Wheelhead to position
		26.6	P2WSD			
		24.5	M6C30			
		26.6	P2WSD			
		5.6	C2			
		18.9	M10C10			
		2.0	RL1			
		12.9	R10D			
		2.0	G.A			
		32.4	AP1	2		
		4.0	M2A	2		
		16.2	AP1			
		14.1	M9C10			
		16.8	G2	3		
		4.0	M2C	2		
		14.1	M9C10			
		11.8	D2D			
		5.6	C2			
		51.6	M30C30			
		2.0	R1			
		43.6				

FORMULA CR-2

MOVEMENT ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
V-2 Place shim under wheelhead						
To shim		R16B	15.8			
		G1B	3.5			
Shim to wheelhead		M16C	18.7			
			15.8	R16B		To wheelhead
			2.0	G1A		
			16.2	AFL		Loosen wheelhead
			13.0	M2B20		Raise
		P16B	10.4			
Shim under wheelhead		M3B	5.7			
		RL1	2.0			
			13.0	M2B20		Lower
			2.0	RL1		
			14.8			
W-2 Remove shim from under wheelhead						
			15.8	R16B		To wheelhead
			2.0	G1A		
			16.2	AFL		Loosen wheelhead
To shim		R16B	15.8	M2B20		Raise
		G1B	3.5			
Remove		M3B	5.7			
			13.0	M2B20		Lower
Layaside		M16B	15.8	RL1		
		RL1	2.0			
			89.8			
X-2 Block wheelhead spindle to remove and mount quiet						
			15.8	R16B		To block
			2.0	G1A		
			13.5	M10C		To pulley
			11.2	G2	2	{ Push on block
			4.0	MFC	2	
			2.0	RL1		
			11.5	R10B		To oil
			2.0	G.A		
To wheelhead spindle		R10B	13.5	M10C		Put to pulley
		G1A	2.0			
Turn spindle		MSC	9.2			
			16.2	P2SE		Put into pulley hole
Turn spindle	2	G2	1.2			
and hold	2	MFC	4.0			
			2.0	RL1		
			16.7	R20W		To balance
			26.7	R30D		To pin in pulley
			2.0	G1A		
			8.9	M6B		Lock out the balance
			5.6	C2		
			7.5	L2E		Remove pin

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left hand	No.	L.H.	T.W.	R.H.	No.	Description-Right Hand
X-2 (continued)						
		8.6	M60			To block
		2.0	M1A			Palm pin
		12.2	M16B			Lay pin and block aside
		2.0	M1			
		<u>217.5</u>				
Y-2 Remove and mount grinding wheel on mill						
		G2	5.6			
Remove wheel and screw from quill		M14B	14.6	M16B		To screw
To screw						Move screw in wheel hole
		2.0	G1A			Grasp wheel
		4.6	M2B			
		5.6	G3			
		R2B	4.0			
		G1A	2.0			
			2.9	M1B		Remove wheel from screw
			7.5	D2E		
			15.8	M16B		Lay wheel aside
			2.0	M1		To blitter
			5.9	R2D		
			3.5	G1B		Blitter to screw
			10.3	M6C		Blitter ex screw
			16.2	P2SE		
			2.9	M1B		
			2.0	M1		To wheel
			8.6	R6B		
			2.0	G1A		Wheel to screw
			10.3	M6C		Wheel ex screw
			16.2	P2SE		
			2.9	M1B		
			5.6	M1		
			0.0	R1		To mill
			10.1	R5D		
			3.5	G1B		
			10.3	M6C		Blitter to screw
			16.2	P2SE		
			2.9	M1B		Blitter on screw
			2.0	M1		
Wheel to quill		M16C	18.7			
Mount on quill		P2SE	16.2			
		M1B	2.9			
		M1	<u>2.0</u>			
			<u>233.4</u>			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
Z-2 Mount and remove wheelhead drive belt						
To belt						
			12.9	R12B		To belt
			2.0	G1A		
			20.6	M24B		Belt to wheelhead
			G1A			
Belt to motor Pulley	M12C	15.2		M6D		
Mount belt	{ 3	G2	16.8			
	3	M1C	10.2			
			7.3	MSA		Draw belt to wheelhead
			16.8	G2	3 }	pulley
			10.2	M1C	3 }	Mount belt
To motor pulley	KL1	2.0		KL1		
	R18D	18.4		R18D		To wheelhead pulley
	G1A	2.0		G1A		
	M4C	8.0				
	2	G2	11.2			
Remove belt	2	M5C	18.4			
		KL1	20.6	M24B		Remove belt & lay aside
			2.0	KL1		
To balance	R12E	11.8		R12E		To balance
		208.4				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand No. L.H. TDU R.H. No. Description Right Hand

A-3 Tighten and loosen wheelhead drive belt

	14.4	R14B	To motor
	.0	G3	
	17.0	SS12C1	
Use both hands	16.2	AP1	} Tighten belt
	10.7	MKA10	
	2.0	RL1	
	26.7	R30S	To rear of motor
	2.0	G.A	
	16.2	AP1	} Loosen belt
	10.7	MKA10	
	2.0	RL1	
	22.9	R30E	To balance
	<u>140.8</u>		

B-3 Swivel the work head 1/2" taper per foot

	40.7	SS18C2	
	15.8	R16B	To worm knob
	16.0	G1A	
	129.6	T906	
	16.0	RL1	Swivel workhead
	37.8	T90S	
	60.7	SS18C2	
	<u>296.6</u>		
Each addition 1/2" taper	<u>199.4</u>		

C-3 Swivel workhead to adjust taper or align load

	40.7	SS18C2	
	15.8	R16B	To worm knob
	2.0	G.A	
	16.2	T90L	
	2.0	RL1	Swivel workhead
	40.7	SS18C2	
	<u>17.4</u>		

D-3 Raise and lower grinding wheel guard by hand

To guard	(2.0)	20.1	R22B	To lock pin
	G1A	1.0	G.A	
		1.0	M2B	
		1.0	D3E	
		2.5	M.A	
				Disengage
Raise guard	M18C	20.4		
	MFC	0.0	(MFC)	
Align holes	P3SD	48.6	P3SD	
		2.5	M1A	
	R1	2.0	RL1	
	R1-F	18.0	R22E	
		59.0		To balance
Lower		<u>159.0</u>		
		<u>379.0</u>		

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
E-3 Reverse table traverse by hand						
To lever	R6B	10.1				
	G1A	2.0				
Reverse Table	AP1	16.2				
	M3A	4.9				
	RL1	2.0				
		<u>35.2</u>				
F-3 Move table by hand one-half inch						
To engaging lever	R6B	17.0	SS12C1			
	G1A	8.6	R6B			To hand wheel
Pull lever up	AP1	2.0	G1A			
	M1A	16.2				
	G2	2.5				
Final lever engagement	AP1	18.7	ML6C			Turn hand wheel
	M1A	16.2				
	G2	2.5				
	AP1	5.6	G2			
	M2A	16.2	1C10			
Disengage	RL1	3.6				Move table 1/2"
		2.0				
	G2	17.0	SS12C1			
	AP1	5.6				
	M2A	17.0				
	RL1	SS12C1				
		153.3				
Each additional 1/2"		14.4				
G-3 Raise and lower workhead guard						
To guard handle	R16B	15.8				
	G1A	2.0				
Raise guard	M20C	22.1				
	RL1	2.0				
To balance	R30E	22.9				
To guard	R30B	25.8				
	G1A	2.0				
Lower guard	M20C	22.1				
	RL1	2.0				
		<u>116.7</u>				

FORMULA GR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
H-3 Mount and remove front or rear splash guard						
	29.0	B				To guard on floor
	2.0	G1A				
	31.9	AB				
	20.4	M18C				To machine
	21.0	P2NSE				Or machine
	9.1	P1SSE				
	2.0	RL1				
	11.5	R1OB				To guard
	2.0	G1A				
	4.0	D1E				Remove
	8.9	M6B				
	2.0	B				Lay aside
	2.0	RL1				
	31.9	AB				To balance
			204.7			
J-3 Move wheelhead cross slide (Set-up)						
	10.1	R8B				To hand wheel
	2.0	G1A				
	149.2	10C10				Move .300"
	2.0	RL1				
			163.3			
L-3 Move wheelhead cross slide (operation)						
	10.1	R8B				To handwheel
	2.0	G1A				
	16.0	3/4C10				Crane to approximate position
	2.0	RL1				
	12.9	R12B				To hand wheel
	2.0	G1A				
	10.2	M1C	3			Move to exact position
	1.2	G2	2			
	1.9	EF	2			
	2.0	RL	2			
			90.3			
M-3 Move Workhead cross slide one half inch						
	40.7	SS H2				To handwheel
		RTAC				
	2.0	G1A				
	62.8	4C10				Move one inch
	2.0	RL1				
	40.7	SS H2				To balance
			148.7			
Each additional 1/8"				14.4		

METHODS ANALYSIS CHART

FORMULA CR-2

Description-Left Hand	No.	LM	TMU	R.H.	No.	Description-Right Hand
N-3 Move Workhead cross slide to dial reading						
	12.9		R10D			To crank handle
	19.6		M3A	4		Tap handle with hand
	22.8		M3B	4		
	29.2		EF	4		Read dial
	<u>2.0</u>		RL1			
	<u>86.5</u>					
P-3 Open or close air supply for hose						
	42.9		SS20C2			To air hose
	29.0		B			
			R10E			To valve
	2.0		G1A			
	8.0		M4C			Open or close valve
	2.0		RL1			
	31.9		AB			
	<u>42.9</u>		SS20C2			To work area
	<u>159.8</u>					
Q-3 Tap object with hammer						
	18.7		M16C			Hammer to object
	5.6		P1SE			
	41.4		M4B	6	?	Hammer object
	<u>36.6</u>		M4A	6)	
	<u>102.3</u>					
R-3 Blow off part (air)						
	12.9		R12B			To nozzle
	2.0		G1A			
	8.9		M6B			Off hook
	13.4		M12B			To part
			SK			
	10.6		AP2			Press button
	27.6		M4B	4		Blow off
	17.0		M18B			To hook
	5.2		M2C			
	5.6		P1SE			Into hook
	2.0		RL1			
	<u>11.8</u>		R12E			To balance
	<u>117.0</u>					
S-3 Wipe object off with cloth						
Case I - Small object						
	18.6		R20B			To cloth
	2.0		G1A			
	15.8		M16B			Cloth to part
	53.4		M6B	6		Wipe off
	18.2		M20B			Lay cloth aside
	<u>2.0</u>		RL1			
	<u>110.0</u>					
Case II - Large object						
Case I	110.0					
	<u>53.4</u>		M6B	6		Additional wiping
	<u>163.4</u>					

METHODS ANALYSIS CHART

FORMULA CR-2

Description-Left Hand	No.	L.H.	DNU	R.H.	No.	Description-Right Hand
T-3 Dress diameter of wheel with carborundum "stick"						
	12.9	R12B				To "stick"
	2.0	G1A				
	18.7	M16C				"Stick" to wheel
	400.0	EST				Dress time
	15.8	M16B				Lay aside
	2.0	EL1				
	<u>451.4</u>					
U-3 Set step on wheelhead cross slide hand wheel						
	11.5	R10B				To compensating knob
	30.0	G1A	15			
	73.5	M3A	15			Turn knob
	30.0	EL1	15			
	79.5	R3B	14			
	<u>224.5</u>					
V-3 Wipe off holding surfaces of 3 jaws with hand						
	14.2	R12D				To jaw
	17.1	M3B	3			Wipe 3 jaws
	14.6	R3D	2			
	12.9	R12B				To balance
	<u>58.8</u>					
W-3 Bring grinding wheel to face of work with facing attachment						
	15.8	R16B				To lever
	2.0	G1A				
	5.7	M3B				
	29.2	EP	4			Wheel to work
	8.0	M16C	4			
	2.0	EL1				
	<u>62.7</u>					
X-3 Dress face of grinding wheel with carborundum "stick" (new wheel) Operator has "stick" in hand after dressing diameter						
	9.2	MSC				To whee.
	250.0	EST				Dress time
	8.0	M16B				To balance
	<u>267.2</u>					

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
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Y-3 Dress face of grinding wheel with carborundum "stick" (operation)

12.9	R12B	To "stick"
2.0	G1A	
20.4	M18C	To wheel
75.0	EST	Dress time
17.0	M18B	Lay aside
<u>2.0</u>	<u>SL1</u>	
<u>129.3</u>		

Z-3 Obtain and lay aside chuck removing board

18.6	TBC1	
30.0	W2P	To bench
29.0	S	To board
2.0	G1A	
31.9	AS	
37.2	TBC2	
30.0	W2P	To machine
18.2	M20B	Board under chuck
<u>2.0</u>	<u>SL1</u>	
<u>198.9</u>		
<u>198.9</u>		Remove & lay aside
<u>397.8</u>		

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	R.H.	No.	Description-Right Hand
A-4 Mount workhead guard						
Same motion pattern						
			35.0	M20B30		Guard on bed
			5.6	G2		
			16.2	AP1		
			37.9	M18C30		Guard to workhead
			48.6	P3SD		
			5.6	G2		
			17.7	M2C15		To next position
			48.6	P3SD		
			42.4	AP2	4	
			8.0	M2B	4	
			2.0	EL1		
			267.6			
B-4 Remove Workhead guard						
Same motion pattern						
			25.8	R30B		To guard
			2.0	G1A		
			42.4	AP2	4	
			8.0	M2B	4	
			22.4	G2	4	
			23.6	D2D	2	
			17.0	M18B		Lay on bed
			5.6	G2		
			16.2	AP1		
			18.2	M20B		To body
			181.2			
C-4 Remove and replace diamond holder unit						
Replace						
			15.8	R16B		To unit
			2.0	G1A		
			7.5	D2E		Remove
			15.8	M16B		Lay aside
			2.0	EL1		
			43.1			
			43.1			
			86.2			
D-4 Mount and remove radius dresser						
			25.6	M20C5		Dresser to truing unit
			5.6	P1SE		
			5.6	G2		
			2.0	MFC		
			5.6	P1SE		
			2.0	EL1		
			18.6	R20B		To dresser
			2.0	G1A		
			21.2	M20B5		Remove
			88.2			

FORMULA CR-2
METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	L.H.	No.	Description-Right Hand
E-4 Additional to tighten and loosen screw with Allen wrench						
	13.5	M10C				Pipe to Allen wrench
	11.2	P1SD				
	8.9	M6B				Tighten screw
	16.2	API				
	4.0	DIE				
	12.2	M10M				To balance
	66.0					
Loosen			66.0			
			<u>132.0</u>			
F-4 Set radius on radius dresser						
To dresser	R12B	12.9				To diamond holder
	G1A	2.0				
		3.4				
		2.0				
		16.2				
	RL1	2.0				
		<u>38.5</u>				
G-4 Pick up and lay aside tool						
Same as element Z-2 in Formula CR-1						
		67.1				
H-4 Lay aside and obtain new part (over 5#)						
	21.4	M16B10				To body
	18.6	TBC1				
	30.0	W2P				
Same motion pattern						
	31.9	S				To box
	21.4	M16B10				Lay in box
	2.0	RL1				
	15.8	R16B				To another part
	2.0	G1A				
	21.4	M16B10				Remove
	31.9	AS				
	18.6	TBC1				
	30.0	W2P				To machine
	21.4	M16B10				To holding device
	<u>266.4</u>					
J-4 Move workhead barrel stop unit to or from indicator						
	R12B	12.9		R12B		To unit
	G1A	2.0		G1A		
3	M1C	10.2		M1C	3	To or from indicator
2	G2	11.2		G2	2	
	RL1	2.0		RL1		
		<u>38.3</u>				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMU	L.H.	No.	Description-Right Hand
M-4 Mount and remove part or fixture on magnetic chuck						
	6.9	M4B				To chuck
	3.4	M1C				
	32.4	P23E	2			Align
	2.0	RL1				
	6.4	D4B				To part
	14.7	M2C5				Slide off
	7.5	D2E				
	6.9	M4B				To balance
	<u>80.2</u>					
M-4 Deburr sharp edge with stone						
	17.2	R18B				To stone
	2.0	G1A				
	25.5	M24C				Stone to edge
To jog button	R12D		14.2			
	G5					
	AP1		16.2			
	75.0	EST				Burr time
	20.6	M24B				Lay aside stone
	2.0	RL1				
	<u>172.7</u>					
Each additional sharp edge						
	8.0	M4C				
	75.0	EST				Burr time
	<u>83.0</u>					
P-4 Place bolt in chuck fixture or face plate and run in						
To bolt	R16B		15.8			
	G1A		2.0			
Bolt to chuck	M16C		18.7			
Time for restricted area	EST		100.0			
	30	M1B	87.0			
Run bolt in	30	RL1	60.0			
	29	R1B	72.5			
	29	G1A	58.0			
	<u>414.0</u>					
Q-4 Run out bolt in chuck, fixture or face plate and lay aside						
To bolt	R16B		15.8			
	30	G1A	60.0			
Run bolt out	30	M1B	87.0			
	29	RL1	58.0			
	29	R1B	72.5			
	D2D		11.8			
Lay aside	M16B		15.8			
	RL1		2.0			
	<u>322.9</u>					

FORMULA CR-2

MOVING ANALYSIS CHART

Description-Left hand	No. L.H.	Time	R.H. No.	Description-Right hand
R-4 Tighten or loosen bolt in chuck, fixture or 1-1/4" plate with wrench				
	13.5	M16C		Wrench to bolt
	75.9	P2880	3	
	31.8	M16	3	Tighten
	22.5	D2E	3	
	23.6	M16C	2	
	32.4	API	2	
	12.2	M16B		Wrench to body
	<u>12.2</u>			
	<u>211.9</u>			
S-4 Move indicator to part				
	15.8	R16B		To indicator stand
	2.0	G1A		
	12.2	M16B		To work
	5.6	G2		
	5.2	M16C		Indicator to work
	16.2	P2880		
	2.0	EL1		
	<u>11.0</u>	R12E		To balance
	<u>70.8</u>			
T-4 Remove one finger back stop in chuck				
	12.9	R12B		To wrench
	2.0	G1A		
	18.7	M16C		Wrench to screw
	25.3	P2880		
To nut	R14D	15.6		
	G1A	2.0		
		5.6	G2	
		58.0	M16	20
		40.0	EL1	20
		47.5	R12	19
		38.0	G1A	19
		7.5	D2E	
	G2	5.6	G2	Palm wrench
			M2B	
		8.4	D4D	To stop
		2.0	G1A	
Remove and lay aside nut M16B		15.8	M16B	Remove and lay aside stop
	EL1	<u>2.0</u>	EL1	
		<u>306.9</u>		

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.S.U	R.H.	No.	Description-Right Hand
U-4 Stone sharp edges of 3 jaws						
	17.2	R12B				To stone
	2.0	G1A				
	20.6	M2B				Stone jaws
	1200.0	EST				Stoning time
	20.6	M24B				Lay stone aside
	2.0	ML1				
	<u>1262.4</u>					
V-4 Tighten and loosen thumb screw hand tight						
	12.9	R12B				To screw
	2.0	G1A				
	9.2	M2B	2	2		Tighten
	11.2	G2				
	16.2	AP1				
	2.0	ML1				
	12.9	R12B				To screw
	2.0	G1A				
	16.2	AP1				
	9.2	M2B	2	2		Loosen
	11.2	G2				
	2.0	ML1				
	<u>107.0</u>					

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TME	R.H.	No.	Description-Right Hand
W-4 Close & Open extended bridge steadyrest			40.7		SS18C2	
To upper section	RL2	21.5		R24B		Step to the right
	G1A	2.0		G1A		To upper section of
Swing down	M6C	13.5		M10C		steadyrest
		5.6		G2		Swing down
		2.0		Mfc		Align
		2.0		RL1		
		10.1		R6B		To clamp
		2.0		G1A		
		8.9		M6B		Swing clamp up
		16.2		AP1		and secure steadyrest
Hand to balance	RL1	2.0		RL1		
	R12E	11.8		R12E		Hand to balance
		40.7		SS18C2		To work area
			40.7		SS18C2	Step to left
			12.9		R12B	To clamp
			2.0		G1A	
			16.2		AP1	Remove steadyrest clamp
			8.9		M6B	
			2.0		RL1	
To steadyrest	R16B	15.8		(R16)		To steadyrest
	G1A	2.0		G1A		
Swing up	M6C	23.8		M22C		Swing up
	RL1	2.0		RL1		
Hand to balance	R24E	19.2		R24E		Hand to balance
		40.7		SS18C2		Step to left
		365.2				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	TMS	R.H.	No.	Description-Right H
X-4 Move workhead on extended bridge 36" (average)						
Crank to pinion			150.0	W10P		To rear of machine
Crank on pinion			10.3	M6C		Crank to pinion
			19.7	P28SE		Crank on pinion
			2.5	M1A		
			5.6	LL1		
			200.5	5-C6 ⁴⁰) 2812C1		Move workhead 12"
			2.0	RL1		
To rack	R12B	12.9	—	R12B	2	Loosen nut element
	G1A	2.0	—	G1A		To crank
Move pinion to new pos.	M12B	68.7	5C6 2812C1			Move pinion to new p
	RL1	2.0	—	RL1	2	Tighten nut element
		12.9	—	R12B		To crank
		2.0	—	G1A		
		200.5	5-C6 ⁴⁰) 2812C1			Move workhead 12"
		2.0	—	RL1	2	Loosen nut element
To rack	R12B	12.9	—	R12B		To crank
	G1A	2.0	—	G1A		
Move pinion to new pos.	M12B	68.7	5C6 2812C1			Move pinion to new p
	RL1	2.0	—	RL1	2	Tighten nut element
		12.9	—	R12B		To crank
		2.0	—	G1A		
		200.5	5-C6 ⁴⁰) 2812C1			Move workhead 12"
		5.6	—	G2		
		8.9	—	M6B		Remove crank
		18.6	—	TBC1		
		195.0	—	W13P		To front of machine
		1222.7				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.M.	R.H.	No.	Description-Right Hand
Y-4 Mount steadyrest on extended bridge & remove						
To steadyrest			29.0	S		
	R12B	12.9	R12B			To steadyrest
	G1A	2.0	G1A			
		31.9	AS			
		18.6	TBC1			
		34.0	W2P0			
Lay steadyrest on swivel plate	M16C ²⁵	33.0	M16C ²⁵			To bridge
Steadyrest to slot keyway into slot	G2	5.6	G2			Lay steadyrest on swivel plate
	M6C ¹⁰	15.3	M6C ¹⁰			
	P38SD	52.1	P38SD			Steadyrest to slot keyway into slot
	G2	5.6	G2			
Slide steadyrest on plate and hold	M2C ¹⁰	9.7	M2C ¹⁰			Slide steadyrest on plate
		2.0	RL1			
		10.1	R6D			To "T" bolt
		2.0	G1A			
		19.7	P28SE			Align "T" to slot
		2.0	RL1			
		12.9	R10D			To 2nd "T" bolt
		2.0	G1A			
		19.7	P28SE			Align "T" to slot
		2.0	RL1			
	G2	15.8	R16B			To steady rest
		2.0	G1A			
Slide steadyrest to position	{ 6 M6B ¹⁰	36.6	M6B ¹⁰	6 } 6 } Slide steadyrest		
	{ 5 G2	28.0	G2	5 } 5 } to position		
	RL1	2.0	RL1			
Hand to balance	(R12D)	14.2	R16E			Hand to balance
	R12B	15.8	R16B			To steadyrest
	G1A	2.0	G1A			
Slide steadyrest to edge of plate	{ 8 AP1	16.2	AP1			
	{ 8 M1B ¹⁰	56.8	M1B ¹⁰	8 } 8 } Slide steadyrest to		
	G2	5.6	G2	edge of plate		
Remove from slot	D2D	11.8	D2D			Remove from slot
To body	(M12B ²⁵)	29.3	M12B ²⁵			To body
	TBC1	18.6	TBC1			
		34.0	W2P0			
		29.0	S			
Lay aside	M12B25	26.3	M12B ²⁵			Lay aside
	RL1	2.0	RL1			
		31.9	AS			To balance
		700.0				

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.M.	R.H.	No.	Description-Right Hand
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Z-4 Set one steadyrest jaw to part

To jaw and hold	R16B	15.8	R16B	40	To jaw adjusting screw
	G1A	80.0	G1A		Turn screw to move
		116.0	M1B		jaw
	R11	80.0	R11		
		100.0	R1B	Hand to balance	
Hand to balance	R16E	14.2	R16E		
		<u>406.0</u>			

A-5 Adjust one steadyrest jaw to part

14.2	R12D	To wheelhead quill with indicator	
8.0	G1A	4	To adjusting screw
26.8	M3C		Turn quill and sweep
8.0	R11		indicator over diameter
15.9	R3B		of part
29.2	RF		
15.8	R16B	Look at indicator	
20.0	G1A		
20.0	MFB		
20.0	R11		
18.0	RFB		
<u>73.0</u>	RF		
<u>268.9</u>			

FORMULA CR-2

METHODS ANALYSIS CHART

Description-Left Hand	No.	L.H.	T.M.	R.H.	No.	Description-Right Hand
1 Set one steadyrest jaw to part						
To jaw and hold	R16B	15.8		R16B		To jaw adjusting screw
	G1A	30.0		G1A	40	
		116.0		M1B	40	Turn screw to move
	RL1	30.0		RL1	40	jaw
		100.0		R1B	39	
Hand to balance	R16E	14.2		R16E		Hand to balance
		406.0				
2 Adjust one steadyrest jaw to part						
		14.2		R12B		To wheelhead quill with indicator
		8.0		G1A	4	
		26.8		M3C	4	Turn quill and sweep
		8.0		RL1	4	indicator over diameter
		15.9		R3B	3	of part
		29.2		RF	4	
		15.8		R16B		To adjusting screw
		20.0		G1A	10	
		20.0		MFB	10	Turn screw to move jaw
		20.0		RL1	10	
		18.0		RFB	9	
		73.0		RF	10	Look at indicator
		268.9				